NEMATODE POPULATIONS ON ROUNDUP-READY COTTON IN FLORIDA

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Abstract. Population densities of plant-parasitic nematodes were compared on cotton (*Gossypium hirsutum*) varieties in three experiments in north central Florida. In one experiment conducted in 1997, buildup of nematode populations was similar on cotton varieties tolerant to Roundup and varieties that are intolerant. The effects of tillage and cotton variety on nematode populations were examined in the other two experiments. Tillage rarely affected nematode populations, and the effects of cotton variety on nematodes were infrequent and inconsistent. It is concluded that nematode buildup on the Roundup-tolerant and Roundup-intolerant cotton varieties tested was similar. Increase of the root-knot nematode, *Meloidogyne incognita* race 1, during the course of a cotton crop was attributed to the presence of weed hosts, particularly late in the season. In general, lesion (*Pratylenchus* spp.) and dagger (*Xiphinema* spp.) nematodes increased on cotton, while populations of ring (*Criconemella* spp.) and stubby-root (*Paratrichodorus minor*) declined on the crop.

INTRODUCTION

Plant-parasitic nematodes are important pests of cotton (*Gossypium hirsutum*) and other commercial crops. In the southern United States, the most damaging nematodes on cotton are race 3 of the root-knot nematode (*Meloidogyne incognita*) and the reniform nematode (*Rotylenchulus reniformis)* (Starr and Page, 1990).

As cotton acreage increases in Florida, so has the concern with nematode pests and their management (Kinloch and Sprenkel, 1994; Rich et al., 1997). A survey conducted in north Florida in 1990 found root-knot nematodes in 61% of the fields sampled and reniform nematodes in 15% of Florida fields (Kinloch and Sprenkel, 1994). As cotton production expanded into northeast Florida, damage by the sting nematode (*Belonolaimus longicaudatus*) has been observed (Crow et al., 1997; 1998). Since cotton is susceptible to race 3 but not to race 1 of *M. incognita* (Taylor and Sasser, 1978), cotton has been used successfully as a rotation crop in north central Florida in sites where race 1 of *M. incognita* predominates (McSorley and Dickson, 1995).

Roundup-tolerant or "Roundup-ready" cotton varieties can be useful in conservation tillage programs (Brecke, 1997), and so interest in these varieties is increasing. The objective of this research is to determine the nematodes associated with Roundup-ready cotton in north central Florida. Information will be provided on which plant-parasitic nematodes build up on cotton in this part of the state, and on Roundup-ready varieties in particular.

MATERIALS AND METHODS

Three separate experiments were conducted on an Arredondo fine sand (94% sand, 3.5% silt, 2.5% clay) at the University of Florida Green Acres Agronomy Research Farm in Alachua County during 1997 and 1998.

Experiment 1 - - Cotton Varieties, 1997

This experiment consisted of four cotton varieties (Stoneville ST 474, Deltapine NUCOTN 33B, Deltapine DP 5690 RR, Deltapine DP 5415 RR) replicated six times in a randomized complete block design. The suffix "RR" designates a Roundup-ready variety. This experiment followed a winter cover crop of 'Tift Blue' lupin (*Lupinus angustifolius*).

The experimental site was mowed on 25 April 1997 and plots were established with a Brown-Hardin strip-till planter. The area was sprayed with 2 quarts Roundup/acre on 2 May and cotton was strip-till planted on 8 May. Rows were 30 inches wide and 20 feet long and there were four rows per plot. On 9 May, preemergence application of 0.75 lb a.i. Prowl and 1.00 lb a.i. Meturon 4L/acre was made. A 13-5-29-1-2.5 (N-P_2O_5-K_2O-Mg-S) fertilizer was applied at 475 lb/acre on 13 June. An additional 250 lb/acre of the same fertilizer mixture was sidedressed on 8 August and an additional 75 lb N/acre was sidedressed on 13 August. Over-top application of 1.5 pints/acre of Roundup was sprayed over the two Roundup-ready varieties of cotton on 16 June. The two non Roundup-ready varieties were post-direct sprayed with 1.5 pints Gramoxone on 30 June. Insects were controlled by use of 1.5 pints Lannate/acre on 23 June, 30 July, and 18 August. Hand harvesting of the middle two rows of cotton began on 15 September and was completed on 2 October. Soil samples for nematode analysis were collected on 19 November 1997, as described below.

Experiment 2 - - Tillage and Cotton Varieties, 1997

This was a split-plot experiment with four tillage treatments as main plots and three cotton varieties as subplots. All treatment combinations were replicated four times. Individual subplots consisted of four rows, 15 ft long, with 2.5 ft between rows. The four tillage treatments were: no tillage, with and without subsoiling, and conventional tillage, with and without subsoiling. The three cotton varieties used in 1997 were Deltapine DP 5690 RR, Deltapine DP 5415 RR, and Stoneville ST 474.

A winter cover crop of 'Wrens Abruzzi' rye (*Secale cereale*) was mowed on 10 April 1997 to 1-ft height. Conventional tillage plots were remowed close to the ground on 29 April and tilled two times with a rototiller to a depth of 6 to 8 inches. Two qt of Roundup/acre were applied over no-till plots on 2 May. Cotton was planted on 7 May at a rate of 110 seeds per 20 ft of row. A preemergence application of 0.75 lb a.i. Prowl and 1.00 lb a.i. Meturon 4L per acre was made on 9 May. An over-the-top application of 1.5 pt Roundup was applied to the Roundup-ready varieties on 13 June, and the non-Roundup-ready variety (Stoneville ST 474) was mechanically cultivated the same day. A post-direct application of 1.5 pt Gramoxone/acre was made on all cotton on 30 June. Additional hand-weeding of the plots with 'Stoneville ST 474' was necessary on 6 October. A broadcast application of 460 lb/acre of 13-5-29-1-2.5 (N-P_2O_5-K_2O-Mg-S) was applied on 14 May. Sidedress applications of 115 lb/acre of ammonium nitrate were made on 12 June and 26 June. Insects were controlled by applications of 1.5 pt Lannate/acre on 23 June, 30 July, and 18 August. An application of 2 pt Gramoxone/acre was sprayed over the top of the cotton on 12 September as a harvest aid. The middle two rows of each subplot were harvested by hand beginning on 6 October and ending on 22 October. Soil samples for nematode analysis were collected from each subplot on 9 May and 24 September 1997.

Experiment 3 - - Tillage and Cotton Varieties, 1998

The experimental design, fertilizer rates, and crop management practices used in this experiment were similar to those used in Experiment 2. However, the cotton variety Deltapine DP 655 BG/RR was substituted for 'Stoneville ST 474' in 1998. Therefore all cotton varieties used in Experiment 3 were Roundup-ready varieties, and so the weed management protocol for Roundup-ready cotton (see Experiment 2 above) was used for all cotton in this season. Cotton was planted on 15 May and was harvested from 30 October to 13 November. Soil samples for nematode analysis were collected on 28 May and 8 December 1998.

Nematode Samples

Each sample consisted of six soil cores (1 in. diameter and 8 in. deep) collected in a systematic pattern from the center two rows of each subplot. The cores comprising each sample were mixed together, and in the laboratory, a 100-cc soil subsample was removed for nematode extraction using a modified sieving and centriguation procedure (Jenkins, 1964). Extracted nematodes were identified and counted under an inverted microscope. All data were analyzed by an analysis of variance for a split-plot design (Freed et al., 1991), followed by mean separation by Duncan's multiple-range test if appropriate.

RESULTS

Experiment 1 - - Cotton Varieties, 1997

Nematodes found following cotton at this site included ring (*Criconemella* spp.), root-knot (*Meloidogyne incognita* race 1), stubby-root (*Paratrichodorus minor*), lesion (*Pratylenchus* spp.), and dagger nematodes (*Xiphinema* spp.). No differences in numbers of any of these nematodes among the various cotton varieties were observed (Table 1).

Experiments 2 and 3 - - Tillage and Cotton Varities

The same plant-parasitic nematodes found in Experiment 1 also occurred in this site. Nematode numbers shortly after planting and late in each season are shown (Tables 2, 3). However, relatively few significant (P#0.10) effects from cotton variety were observed, and these were inconsistent from year to year (table 4). No significant (at P#0.10) tillage x variety interaction was obtained for any nematode. A significant (P#0.10) tillage effect was obtained for lesion nematodes on 8 December 1998. On that date, significantly (P#0.10) more lesion nematodes were recovered from no-till plots (mean = 31.9 nematodes/100 cc soil) than from the no-till + subsoil plots (15.5/100 cc), the conventional till + subsoil plots (18.7/100 cc), or the conventional till plots (13.6/100 cc).

DISCUSSION

Based on the experiments in which Roundup-ready varieties and nontolerant varieties were compared directly (Experiments 1, 2), it appears that in general, similar numbers of plant-parasitic nematodes built up on Roundup-tolerant and non-tolerant varieties. The greatest difference observed was in the buildup of more dagger nematodes on 'Stoneville ST 474' than on 'Deltapine DP 5690 RR' (Tables 2, 4).

These experiments also provide information on the plant-parasitic nematodes which built up on cotton in north central Florida. Although ring and stubby-root nematodes occurred on cotton at this site, their population levels

declined during the cotton crop in both years (Tables 2, 3). On the other hand, root-knot and lesion nematodes increased during the cotton crop in both years, since their numbers at the end of the season were generally greater than their numbers in samples collected near planting time (Tables 2, 3). In 1997, moderate numbers of dagger nematodes were recovered following the cotton crop, even though their numbers were below detectable levels at planting (Table 2).

The buildup of *M. incognita* on the cotton crop was unexpected, since the *M. incognita* population found in this site was race 1. Cotton is a host to race 3 of *M. incognita* but not to race 1 (Taylor and Sasser, 1978). The presence and increase of *M. incognita* in this field is attributed to weeds which persisted despite the herbicide program used on the cotton crops. Weed hosts of root-knot nematodes which were common in this site late in each season included morningglory (*Ipomoea* spp.) and beggarweed (*Desmodium tortuosum*).Root-knot nematode populations were higher in 1998, when nematode samples were collected after cotton harvest and additional weed growth had occured, than in 1997, when nematode samples were collected before cotton harvest began. No galling from root-knot nematodes was observed on the roots of cotton plants in either season.

It is encouraging that the major nematode pests of cotton - - *M. incognita* race 3, *R. reniformis*, and *B. longicaudatus* - - did not build up on cotton in this location in north central Florida. However, the cultivation of cotton in this area is very recent, and when the crop is grown more often, particularly in the same field, there is increased likelihood that nematode pests characteristic of this crop may build up. *Belonolaimus longicaudatus* is common in the vicinity (Crow et al., 1998; McSorley and Dickson, 1995), although it was not found in this study.

SUMMARY

The use of cotton varieties tolerant to the herbicide Roundup is increasing in the southern United States. However, as the use of new varieties increases, so does the potential for buildup of pest problems characteristic of those varieties. Three experiments were conducted in north central Florida during 1997 and 1998 to examine the buildup of plant-parasitic nematodes on Roundup-ready cotton varieties. In general, the buildup of plant-parasitic nematodes on Roundup-tolerant and Roundup-intolerant cotton varieties was similar. The various kinds of nematodes which occurred in these cotton crops are discussed in detail.

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Table 1. Plant-parasitic Nematode Population Densities Following Four Cotton Varieties, Experiment 1, 19 November 1997.

Cotton variety	Nematode				
	Ring	Root-knot	Stubby-root	Lesion	Dagger
	Nematodes per 100 cc soil				
Stoneville ST 474	86.8	0.2	21.0	25.2	2.0
Deltapine NUCOTN 33B	62.3	7.5	15.8	33.5	3.7
Deltapine DP 5690 RR	99.8	1.8	15.3	18.0	2.5
Deltapine DP 5415 RR	73.8	0.7	15.5	25.7	2.3

Data are means of six replications. No significant differences (P#0.10) in nematode numbers among cotton varieties.

Table 2. Effect of Tillage and Cotton Variety on Population Densities of Plant-parasitic Nematodes, Experiment 2, 1997.

Tillage treatment	Cotton Variety	Ring	Root-knot	Stubby-root	Lesion	Dagger
		Nematodes per 100 cc soil				
		9 May 1997				
NT+sub	–	184.0	7.0	8.5	8.5	0
NT	–	81.0	5.8	16.0	11.8	0
CT+sub	–	174.8	3.0	12.2	2.5	0
CT	–	231.8	11.5	5.5	6.5	0
		24 September 1997				
NT+sub	Deltapine DP 5690 RR	61.5	0	1.0	9.2	1.5
	Deltapine DP 5415 RR	17.2	21.8	0.2	10.2	5.7
	Stoneville ST 474	25.8	36.8	0	3.0	23.2
NT	Deltapine DP 5690 RR	23.5	3.2	0.8	11.0	1.0
	Deltapine DP 5415 RR	56.5	0.2	0.8	13.8	9.5
	Stoneville ST 474	28.2	12.8	0	5.2	21.8
CT+sub	Deltapine DP 5690 RR	25.0	12.8	1.5	7.8	1.8
	Deltapine Dp 5415 RR	29.8	12.2	0.5	19.0	0.8
	Stoneville ST 474	19.0	8.5	0.2	6.2	11.0
CT	Deltapine DP 5690 RR	11.5	11.2	1.8	8.2	0
	Deltapine DP 5415 RR	107.5	35.2	2.0	15.5	0.5
	Stoneville ST 474	18.0	2.5	0.2	6.0	0.8

[1]NT + sub = no-till with subsoil; NT = no-till; CT + sub = conventional till with subsoil; CT = conventional till. Data are means of four replications.

Table 3. Effect of Tillage and Cotton Variety on Population Densities of Plant-parasitic Nematodes,Experiment 3, 1998.

Tillage Treatment	Cotton Variety	Ring	Root-knot	Stubby-root	Lesion	Dagger
		Nematodes per 100 cc Soil				
		28 May 1998				
NT+sub	–	257.5	0.2	36.2	24.5	0
NT	–	93.5	4.0	37.2	8.8	2.8
CT+sub	–	154.8	1.8	58.2	13.0	0
CT	–	199.2	0	77.0	19.2	0
		8 December 1998				
NT+sub	Deltapine DP 5690 RR	3.0	29.2	2.0	14.2	0
	Deltapine DP 5415 RR	26.2	60.5	4.0	13.0	0.5
	Deltapine DP 655 BG/RR	66.2	9.2	5.0	19.2	0
NT	Deltapine DP 5690 RR	38.2	36.0	2.8	29.5	0
	Deltapine DP 5415 RR	74.2	8.8	6.5	33.8	0
	Deltapine DP 655 BG/RR	31.8	60.2	9.0	32.5	0.5
CT + sub	Deltapine DP 5690 RR	10.8	9.8	1.5	20.8	0
	Deltapine DP 5415 RR	32.0	86.0	22.0	21.0	0
	Deltapine DP 655 BG/RR	103.0	13.0	1.0	14.2	0
CT	Deltapine DP 5690 RR	17.0	91.0	1.2	13.0	0
	Deltapine DP 5415 RR	41.8	22.0	1.0	15.0	0
	Deltapine DP 655 BG/RR	95.0	7.0	3.0	12.8	0.8

[1]NT + sub = no-till with subsoil; NT = no-till; CT + sub = conventional till with subsoil; CT = conventional till. Data are means of four replications.

Table 4. Summary of Significant Effects of Cotton Varieties on Plant-parasitic Nematode Populations, 1997 and 1998.

Cotton Variety	Ring	Stubby-root	Lesion	Dagger
		Nematodes per 100 cc soil		
		24 September 1997		
Deltapine DP 5690 RR	–	1.2 a[1]	9.0 b	1.1 b
Deltapine DP 5415 RR	–	0.9 ab	14.6	4.1 ab
Stoneville ST 474	–	0.1 b	5.1 c	14.2 a
		8 December 1998		
Deltapine DP 5690 RR	17.2 b[1]	- -	- -	- -
Deltapine DP 5415 RR	43.6 ab	- -	- -	- -
Deltapine DP 655 BG/RR	74.0 a	- -	- -	- -

Data are subplot (variety) means, across tillage treatments. Means in columns followed by the same letter do not differ at P#0.05, according to Duncan's multiple-range test. Dashes (-) indicate subplot (variety) effect not significant at P#0.10.

[1]Mean separation based on P#0.10.